Customized FORM PTO-1390 U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY DOCKET NO
P07143US00/MP

U.S. APPLICATION NO.
(if known, see 37 CFR 1.5)
09/806770

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DK99/00528	06 OCTOBER 1999	06 OCTOBER 1998

TITLE OF INVENTION: ENVIRONMENT ADAPTABLE LOUDSPEAKER

APPLICANT(S) FOR DO/EO/US: PEDERSEN, Jan A.

Applicant herewith submits to the US Designated/Elected Office (DO/EO/US) the following items and other information

- ☒ 1. This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
- ☐ 2. This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 USC 371.
- ☒ 3. This express request to begin national examination procedures (35 USC 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 USC 371(b) and PCT Art. 22 and 39(1).
- ☒ 4. A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
- ☒ 5. A **copy** of the International Application as filed (35 U.S.C. 371 (c)(2))
  - ☐ a. is transmitted herewith (required only if not transmitted by the International Bureau).
  - ☒ b. has been transmitted by the International Bureau.
  - ☐ c. is not required, as the application was filed in the United States Receiving Office (RO/US).
- ☐ 6. A **translation** of the International Application into English (35 U.S.C. 371(c)(2)).
- ☒ 7. Amendments to the claims of the International Appln. under PCT Article 19 (35 USC 371 (c)(3))
  - ☐ a. are transmitted herewith (required only if not transmitted by the International Bureau).
  - ☐ b. have been transmitted by the International Bureau.
  - ☐ c. have not been made; however, the time limit for making such amendments had NOT expired.
  - ☒ d. have not been made and will not be made.
- ☐ 8. A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
- ☒ 9. An **oath** or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
- ☐ 10. A translation of the annexes to the Int'l Prelim. Exam. Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 20. below concern document(s) or information included:

- ☐ 11. An **Information Disclosure Statement** under 37 C.F.R. 1.97 and 1.98.
- ☒ 12. An **Assignment** document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
- ☐ 13. A **First preliminary amendment**.
- ☐ 14. A Second or Subsequent preliminary amendment.
- ☐ 15. A substitute specification.
- ☐ 16. A change of power of attorney and/or address letter.
- ☐ 17. A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 & 35 USC 1.821-825.
- ☐ 18. A second copy of the published international application under 35 USC 154(d)(4).
- ☐ 19. A second copy of the English translation of the international application under 35 USC 154(d)(4).
- ☐ 20. Other items or information:
  - ☐
  - ☐

- ☐ A copy of the Notification of Missing Requirements under 35 U.S.C. 371.
- ☐ In the event that a petition for extension of time is required to be submitted herewith, and in the event that a separate petition does not accompany this response, applicant hereby petitions under 37 CFR 1.136(a) for an extension of time of as many months as are required to render this submission timely. Any fee is authorized in 17(c).

Date: 03 April 01

LARSON & TAYLOR, PLC • 1199 North Fairfax St. • Suite 900 • Alexandria, VA 22314

U.S. APPLICATION NO. *(If known)*	INTERNATIONAL APPLICATION NO.	ATTORNEY DOCKET NO
09/806770	PCT/DK99/00528	P07143US00/MP

		CALCULATIONS *PTO USE ONLY*
☒	21. **The following fees are submitted:**	
☒	**Basic National Fee** (37 CFR 1.492 (a) (1)-(5):	
☐	Neither Int'l Prelim. Exam. fee nor Int'l Search fee paid to USPTO $1000	
☒	Search Report has been prepared by the EPO or JPO $ 860	
☐	No Int'l Prelim. Ex fee paid to USPTO but Int'l Search fee paid to USPTO $ 710	
☐	International preliminary examination fee paid to USPTPO $ 690	
☐	Int'l Prelim. Ex. fee paid to USPTO & all claims satisfied PCT Art. 33(1)-(4) $ 100	
	ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 860
☐	Surcharge of **$130** for furnishing the oath or declaration later than ☐ 20 mos. ☐ 30 mos. + from the earliest claimed priority date (37 CFR 1.492(e)).	$

CLAIMS	*NUMBER FILED*	*NUMBER EXTRA*	*RATE*	
Total Claims	15 - 20 =		X **$18** =	$
Independent Claims	01 - 03 =		X **$80** =	$
☐ Multiple Dependent Claim(s) (if applicable)			+ **$270** =	$
			TOTAL OF ABOVE CALCULATIONS =	$ 860
☐	Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by ½.		-	$
			SUBTOTAL =	$ 860
☐	Processing fee of **$130** for furnishing the **English translation** later than ☐ 20 mos. ☐ 30 mos. + from the earliest claimed priority date (37 CFR 1.492(f)).			$
			TOTAL NATIONAL FEE =	$ 860
☒	Fee for recording the enclosed **assignment** (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40** per property +			$ 40
			TOTAL FEES ENCLOSED =	$ 900
			Amount to be *Refunded*	$
			Charged	$

☒ a. A **check** in the amount of $900 to cover the above fees is enclosed.

☐ b. Please charge my Deposit Account No. 12-0555 in the amount of $ to cover the above fees.

☒ c. The Commissioner is hereby authorized to charge any additional fees required or credit overpayment to Deposit Account No. 12-0555.

Note: *Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status*

SEND ALL CORRESPONDENCE TO:

MARVIN PETRY

At the address (below) of **CUSTOMER NO. 00881.**

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SIGNATURE: Douglas E. Jackson

NAME: Douglas E. Jackson

REG. NO.: 28518

PHONE NO.: 703-739-4900

Date: 03 April 01

ENVIRONMENT ADAPTABLE LOUDSPEAKER

The present invention relates to a loudspeaker unit of the type having a detector system for measuring the radiation resistance of the loudspeaker diaphragm and for accordingly controlling the transfer characteristics of a correction filter in order to make the loudspeaker unit environment-adaptive.

Such a system is known from WO84/00274, and it is used for adjusting the loudspeaker performance to high fidelity optimum all according to the "sound climate" of the room as seen from the loudspeaker diaphragm, i.e. also all according to the position and direction of the loudspeaker, the aim being to be able to control the acoustic power-output/frequency response in the listening room and to enable readjustment in case of acoustically major changes in the room.

The present invention has a similar aim, and is based on similar considerations as disclosed in the said WO document, so for further background information, reference can be made directly to that document.

In the known system the basic sensor equipment is an accelerometer mounted directly on the diaphragm and a microphone mounted slightly spaced in front of the diaphragm. These sensors will provide the signals required for the determination of the radiation resistance, provided, however, that each of the two sensors will always, i.e. throughout the operational lifetime of the loudspeaker, respond identically to identical signal inputs. Already rather small deviations of one of the sensors may disturb the original calibration significantly, and on this background it is required to use very expensive sensors that will remain stable over some 10-20 years.

According to the present invention it has been found that it is possible to determine the radiation resistance in another way, which is not exactly easier to perform, but can be performed by means of a sensor equipment, the price of which is dramatically reduced, even by a factor of some 500.

The basic consideration is that it is possible to determine changes of the radiation resistance based on a detection of the sound pressure in two (or more) points spaced differ-

ent from the loudspeaker diaphragm, without using an accelerometer in direct connection with the diaphragm. For the relevant purpose it is not required to actually measure the absolute radiation resistance, as it is sufficient to obtain a reference value i.e. the absolute radiation resistance except for a scaling factor, for comparison with later detections of the sound pressures in the same two (or more) points.

According to a first approach it is possible to estimate the surface velocity of the diaphragm based on a measurement of the sound pressure in a point relatively close to the diaphragm and, based thereon, to determine the radiation resistance by measuring the sound pressure at another point, in which the sound amplitude is smaller than at the first point, i.e. a point further spaced from the diaphragm. If one of the positions is much closer to the diaphragm than the second position, then the acceleration (and in turn velocity) of the diaphragm can be estimated from the associated sound pressure, and the radiation resistance is proportional to the ratio between the second sound pressure and the respective first sound pressure.

According to another approach the said acceleration can be estimated from the difference between two measured sound pressures, without the closer position necessarily being very close to the diaphragm. The difference is 90 degrees out of phase with the velocity, i.e. in phase with the acceleration, because the real parts of the two sound pressures divided by the velocity are equal, as would have been the case for the sound pressures in any two points close to the diaphragm. The amplitude of the difference is proportional to the acceleration because reflections from the environment tend to contribute equally to the two sound pressures and therefore cancels when calculating the difference.

Both of these approaches imply the use of two measurements by the same type of sensor, viz. microphones, and according to the invention this opens for the possibility of using but a single sensor for effecting both of the required measurements, viz. when these are made in a successive manner with a single microphone physically responding to the air

pressures in the respective two positions. This will be a matter of changing the microphone position within a time interval of a few minutes only, and it can be assumed realistically that during this lapse of time the microphone will not change its transfer function significantly. If a new measurement is made e.g. three years later it will be without importance whether the transfer function of the sensor has undergone a change in the meantime, since what matters will, still be that this function is unchanged during the few minutes required for the new measurement.

An alternative will be to use a single microphone which is stationarily positioned at one end of one or two sound guiding tubes having their free ends located at the respective different positions, with associated valve means for selectively connecting the microphone acoustically with the respective positions.

The above measures will account for the use of a sensor which is not at all supposed to behave in a stable manner year after year, and accordingly the associated costs of such sensors may be drastically reduced as already mentioned.

In practice an alternative will be the use of two cheap microphone units which are arranged so as to be interchangeable between two opposed positions, one relatively close to the diaphragm, e.g. a few centimetres therefrom, and one some centimetres further away. Two microphones can also be used in the way that one measurement is made with the microphones correspondingly interspaced and another measurement with the microphones moved closely together, whereby it is possible to conduct a separate calibration and thus make the first measurement of two sound pressures reliable for the determination of the radiation resistance. Of course, measurements may be made in more than two positions for refining the result.

It has been demonstrated in practice that the estimation of the diaphragm velocity based on a measurement of the sound pressures is sufficiently representative for the present purpose, provided the sound pressures are measured at distances which are short compared to the wave length, e.g. shorter than 1/8 of the wave length.

In the following the invention is described with reference to the drawing, in which

Fig. 1 is a perspective view of a loudspeaker unit according to an embodiment of the invention,

Fig. 2 is a schematic lateral view of a modified loudspeaker, and

Figs. 3-5 are similar views of further modifications.

The unit shown in fig. 1 comprises a box 2 with a mounting plate 4 for a tweeter 6 and a woofer 8.

In front of the woofer a cross bar 10 is mounted, extending from a motor housing 12 having means for rotating the bar 10 through 180°. Outside the center of the woofer 8 the bar 10 has a branch rod 14 carrying at its outer end a small microphone 16, which will thus be rotatable between a position facing the woofer, and as shown at 16', an inverted position further spaced from the woofer.

As explained above, by a detection of the sound pressure in first one and then the other of these two positions of the microphone it is possible, in a unit 18, to calculate the radiation resistance of the woofer diaphragm, and then to apply a corresponding control signal to a filter unit 20 arranged in the signal line to the loudspeaker unit, preferably before the amplifier 22. The filter 20 is relevant only for the performance of the woofer, while a similar system could be advantageous for correspondingly controlling e.g. a mid-range loudspeaker.

An adjustment of the filter 20 could be effected automatically at regular intervals or even in response to detection of an apparent change of the radiation resistance; the unit 18 will then get the opportunity to make sure whether the change is real or only owing to drift of the microphone. Preferably, however the loudspeaker or the reproduction set including the loudspeaker is provided with a control button to be actuated by the user whenever changes are brought about in the room acoustics.

Alternatively, the parts indicated 14' and 16' could be real parts, i.e. with 16' representing an additional micro-

phone positioned symmetrically with the microphone 16 with respect to the axis of the rod 10, such that the two microphones can be swapped between the same two positions, and then enable relative calibrations of the two microphones.

Still a further alternative, which is illustrated in Fig. 2, is to arrange one of these microphones, 16, stationarily in one of the two positions and provide for the other microphone 16' to be shiftable between the two positions, in close proximity with the first microphone in the common position of the two microphones. The microphone 16' may hereby be slidably arranged along a support 17. Some lateral spacing may be acceptable in the common position, but the distance to the diaphragm should be substantially the same. In this system the microphones should be connected to a calibration unit 24 associated with the processing unit 18, for calibration when the microphones assume the common position.

Alternatively, the support 17 may carry both microphones 16 and 16' in a slidable or otherwise shiftable manner such that they can be swapped between the respective two positions, e.g. by a translatoric movement along the support 17, in order to enable double relative calibration of the microphones, just as when two microphones are used in the system shown in Fig. 1.

A still further alternative is illustrated in Fig. 3. A single microphone 16 is mounted in connection with a housing 26 having two tubes 28 and 30 pointing towards the diaphragm 8, the housing 26 holding a switch valve plate 32 that can be switched over so as to connect the microphone 16 with either one or the other tube. The sound pressure detected by the microphone will be representative of the sound pressure at the open end of the respective tube, inasfar as the sound will not be further spread by its passage through the tube. The sound waves create a pumping effect which is transmitted through the tube. For that sake, such a tube may extend even in the opposite direction as shown at 32 in dotted lines. At the relevant low frequency range the microphones will be omnidirectional. However, even if a microphone is not fully omnidirectional, the only consequence will be that it will not

detect the sound pressure directly at the tube end, but somewhat spaced therefrom, thus still measuring the pressure "in a second position". When only the measuring conditions are unchanged over time, then the measuring results will still be representative for the relevant purpose.

Fig. 4, by way of example, shows a modification of the system shown in Fig. 3. Two stationary microphones 16 and 16' are used, each acoustically connectable with two tubes 28, 30 and 28', 30', respectively, through respective switch over valves 32 and 32'. The two tube pairs 28, 28' and 30, 30' merge into respective common tubes 28" and 30" having free ends located differently spaced from the diaphragm. By operating the valve plates 32, 32' suitable, it is possible to connect one microphone (16 or 16') with the pipe 28" and at the same time connect the other microphone with the tube 30", whereafter these connections can be swapped for a new measurement. The effect will be identical with the physical swapping of two microphones as mentioned in connection with Fig. 1, though now without requiring the microphones to be located differently spaced from the diaphragm. They should not either necessarily be equally spaced therefrom, as the said relative calibrations will be achievable anyhow, given that the two microphones are exposed to the same sound signal during each of the measurements. Only the amplitude or sound pressure of the signal will be different, given by the respective positions of the free ends of the tubes 28" and 30".

A further modification is illustrated in Fig. 5, showing a stationary microphone 16 held by a carrier arm 34 and surrounded by a sleeve member 36, which is operable to be displaced from a retracted position, in which its free end is located behind the microphone 16 or behind the outer end of a tube portion 38 projecting forwardly therefrom, to a projected position in front of the microphone or its associated tube 38. Already by this measure it will be ascertained that the required two measurements be made by different sound pressures, whereby it is not necessary to arrange for a displacement of the microphone itself.

Alternatively, the tube 38 may be a flexible hose, the free end of which is positionable in respective fixtures in well defined positions differently spaced from the diaphragm.

The invention is not limited to the use of only one or two microphones, or to the use of only two measuring positions.

For further explanation with respect to the physics and mathematics of the invention reference is made to the Danish patent application No. 1256/58, from which priority is claimed; the files of that application were made accessible to the public by 05.10.99.

As additional background disclosure, reference can be made to the Japanese patent Application no. JP 09233593 A, published by 05.09.97.

C L A I M S:

1. A loudspeaker of the type having sensor means for the determination of the radiation resistance of the diaphragm, expressed by the velocity/acceleration of the loudspeaker diaphragm and the sound pressure in a distance from the diaphragm, and thereby, via a signal processing unit, provide a control signal to a filter unit adjusting the performance of the loudspeaker in an adaptive manner to the acoustical characteristics of the listening room, said sensor means comprising a microphone for detecting said sound pressure, characterized in that the sensor equipment comprises microphone means for detecting the sound pressure in at least two points differently spaced from the diaphragm, and that carrier means are provided enabling one same microphone to be effectively and successively exposed to the sound pressure in each of the at least two points.

2. A loudspeaker according to claim 1, in which the carrier means are operable to shift the microphone between said two points.

3. A loudspeaker according to claim 2, in which the carrier means are rotatable.

4. A loudspeaker according to claim 2, in which the position of the microphone is shiftable by a translatoric displacement along the carrier means.

5. A loudspeaker according to claim 1, in which a microphone is mounted in a staionary position and is acoustically connected with a sound guide tube having a free end located spaced from the diaphragm, said tubee being telescopically or otherwise adjustably arranged so as to enable its free end to be shiftable between positions differently spaced from the diaphragm.

6. A loudspeaker according to claim 1, in which a microphone is mounted in a stationary position and operatively coupled to the sound field through tube means having free ends located at positions differently spaced from the dia-

phragm, valve means being provided for acoustically connecting the microphone selectively with either of said free ends.

7. A loudspeaker according to claim 1, in which a first microphone is stationarily mounted in a first position and a second microphone is mounted so as to be physically displaceable between at least one second position and said first position, in close proximity to the first microphone in that position, both of the microphones being connected to a calibration unit in said signal processing unit.

8. A loudspeaker according to claim 1, in which two microphones are arranged in connection with a carrier system enabling the two microphones to be operatively swapped between the two positions and, optionally, further positions.

9. A loudspeaker according to claim 8, in which the microphones are mounted on a rotatable carrier so as to be interchangeable by rotation of the carrier.

10. A loudspeaker according to claim 7, in which the microphones are arranged on a support so as to be shiftable by a translatoric movement therealong.

11. A loudspeaker according to claim 5, in which two microphones are mounted in stationary positions, each selectively connectable with sound guide tubes having respective free ends located differently spaced from the diaphragm.

12. A loudspeaker according to claim 1, in which one or more microphones are shiftable between three or more different positions differently spaced from the loudspeaker diaphragm.

13. A loudspeaker according to claim 1, in which a first measuring point is located spaced 1-5 cm from the diaphragm and a second measuring point is spaced 3-20 cm from the diaphragm.

14. A loudspeaker according to claim 1, in which the sound pressure is detected in a first point relatively close to the diaphragm, e.g. 1-2 cm, and in a second point further spaced from the diaphragm, and in which the signal processing unit operates to calculate the real part of the product of j (square root of minus 1) and the ratio between the sound pressures in the second and the first point, respectively.

15. A loudspeaker according to claim 1, in which the sound pressure is detected in two points differently spaced from the diaphragm, and in which the signal processing unit operates to calculate the real part of the product of j and the ratio between a sound pressure P and the difference between the sound pressures in the said first and second points, P being either one of the two measured pressures or a mean valve thereof.

1/1

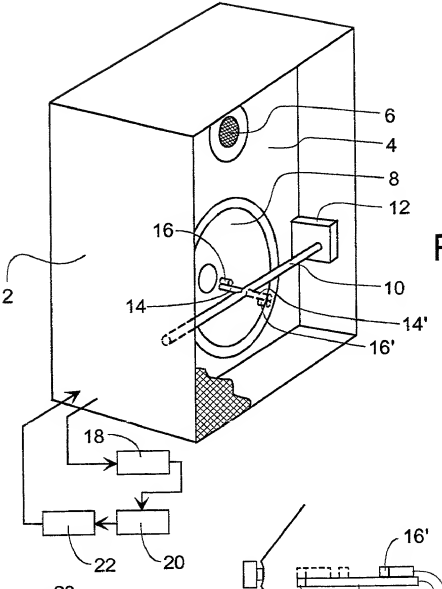
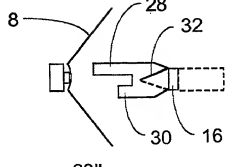


Fig.1

Fig.3



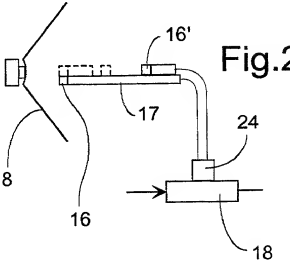


Fig.2

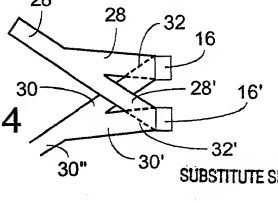


Fig.4

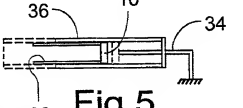


Fig.5

DECLARATION FOR USA PATENT APPLICATION

(including Design and National Stage PCT) Attorney's Docket ID: _____

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below adjacent to my name. I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought

on the invention entitled ENVIRONMENT ADAPTABLE LOUDSPEAKER

_____, the specification of which

___ is attached hereto. (or)

_X_ was filed on 6 Oct. 1999, [ ] and was amended on _____.

[ ] as U.S. Application No. _____ or

[X] as International PCT Application No. PCT/DK99/00528

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 (a) - (d) or §365 (b) of any foreign application(s) for patent or inventor's certificate, or §365 (a) of any PCT International application which designated at least one country other than the United States of America, listed below and have also identified below, where priority is not claimed, any foreign application for patent or inventor's certificate, or any PCT International application, having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s) (____ ADDITIONAL APPLICATIONS IDENTIFIED ON ATTACHED SHEET):

Number	Country	Day/Month/Year Filed	Priority Not Claimed
PA 1998 01256	Denmark	6 October 1998	___
			___

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s), or §365(c) of any PCT International application designating the U.S., listed below; and insofar as the subject matter of each claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application. (____ ADDITIONAL APPLICATIONS IDENTIFIED ON ATTACHED SHEET.)

Application Serial No.	Day/Month/Year Filed	Status -- patented, pending, abandoned

I hereby appoint the practioners of **LARSON & TAYLOR** associated with the Customer Number provided below to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and direct that all correspondence be addressed to that Customer Number.

CUSTOMER NUMBER: 00881

Direct all telephone calls to _____, at TEL (703) 739-4900 (Fax: 703-739-9577)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under § 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Sole or First Inventor: Jan Abildgaard PEDERSEN	Citizenship: Danish
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Residence - City, State/Country (if different from P.O. address): Same as P.O. address DKX	
SIGN AND DATE HERE: Inventor's Signature: Jan A. Pedersen	Date: 22. Marts 2001
Full Name of Second Joint Inventor, if any: Ole PLOUG	Citizenship: Danish
Full Post Office Address: Duevej 19, DK-7600 Struer, Denmark	
Residence - City, State/Country (if different from P.O. address): Same as P.O. address DK-X	
SIGN AND DATE HERE: Inventor's Signature: Ole Ploug	Date: 24. MARTS 2001
Full Name of Third Joint Inventor, if any	Citizenship
Full Post Office Address	
Residence - City, State/Country (if different from P.O. address)	
SIGN AND DATE HERE: Inventor's Signature:	Date:
Full Name of Fourth Joint Inventor, if any	Citizenship
Full Post Office Address	
Residence - City, State/Country (if different from P.O. address)	
SIGN AND DATE HERE: Inventor's Signature:	Date:

____ SEE ATTACHED SHEET FOR SIMILAR INFORMATION AND SIGNATURE FOR ADDITIONAL JOINT INVENTORS.